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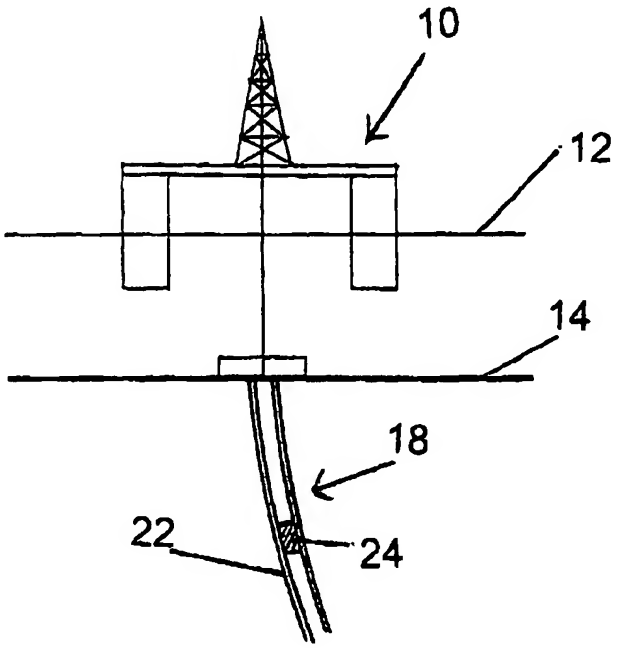
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) **Title:** METHOD AND DEVICE FOR TESTING A WELL



(57) **Abstract:** A method and a device for testing of a well, such as in a well liner, a newly drilled hole, and the like, is disclosed. The method is characterised in that a plug is directed down into the well, that the plug is fixed towards the wall of the well the sealing means of the plug is activated to seal against the wall of the well, and after the testing has ceased the sealing function is removed by disintegrating the plug. Preferably a plug of a disintegratable material is used, such as a ceramic material, glass or the like.

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Method and device for testing a well

The present invention relates to a method and a device as disclosed in the introduction to the subsequent claims 1 and 9 respectively.

Furthermore, the invention is concerned with a method and a device for testing of wells, production pipes and the like during drilling, testing, logging and production of hydrocarbons, both from land based sites and offshore.

Today, leak tests are carried out with the aid of plugs when, for example, a well liner or a production pipe shall be pressure tested. The plug is driven down into the hole and fixed. It is also tested before the real test itself to determine whether it is leak-proof, and must as a rule be adjusted or replaced. When the test has been completed, the plug must be brought up from the hole by means of a special tool. There is a chance that this will fail, and a larger operation with a fishing tool to bring the plug up must be initiated.

There is indeed a known solution where the whole, or parts of, the plug is manufactured from rubber, and where a section comprises a chemical which dissolves the rubber plug when the test is completed and one wishes to remove the plug.

It is an object of the invention to provide a new type of plug that completely eliminates the above mentioned problems, i.e. a plug for which it is absolutely not

necessary to pick up the remains when it is destroyed down in the hole.

Furthermore, it is an object of the invention to provide a plug type that does not represent any fouling of the hole.

The method according to the invention is characterised in that a plug is conducted down in the well, that the plug is fixed against the wall of the well, that the sealing means of the plug are activated to make a seal with the wall of the well, and after the test has been completed, the sealing function is removed by the plug being disintegrated.

Further features of the method are disclosed in the dependent method claims.

The device according to the invention is characterised by a plug which is arranged to be fixed against the wall of the well or liner, that the plug is comprised of sealing means which are arranged to make a seal with the wall of the well, with the plug being comprised of a material which can disintegrate.

Further features of the invented device are disclosed in the dependent claims 10-15.

Provided now is a plug of a material which can disintegrate or be crushed by an applied pressure, such as impact pressure from a fluid, by detonation of a small explosive charge/ignition system with time lag, or by means of a drill bit. The plug material which can disintegrate or be crushed, is preferably made from a ceramic material, from glass, or from another material which can be crushed. Crushed means also that it shall be possible to pulverize the material into an unproblematic material consisting of small particles. Furthermore, the material must consist of a material which is resistant to corroding fluid and gas environments. Furthermore, the material must be so durable that the plug can remain in the well as a permanent plug. Furthermore, the plug can be manufactured in all possible dimensions for the operations where previously conventional plugs were used.

Preferably a ceramic material is used, such as a cold or hot moulded sintered material, such as compression moulded material, or melt cast material.

The plugs can be conducted down through a pre-fabricated casing (liner) of a tube or a wire and be fixed at a desired depth. The plug is removed by disintegration.

The plug according to the invention can be pre-fabricated in a "pop joint" which is fitted to the string at a correct depth, and then the whole assembly is conducted down into the hole.

Alternatively, the plug can be driven down in the liner pipe on a pipe or a wire, and then be fixed at a desired depth. The plugs are removed as described above. The setting of plugs will never take more than one run.

The invention shall now be explained further with reference to the subsequent figures in which:

Figure 1 shows an application of the device according to the invention in connection with a drilling hole which is served from a semi-sub platform.

Figure 2 shows a cross-section of a plug according to the invention.

Figure 3 shows a test plug fitted to a liner section.

Figure 4 shows a test plug which is inserted after the liner is fitted.

Figure 5 shows a plug construction for a casing, and which is arranged for disintegration by direct mechanical means.

Initially, reference is made to figure 1. Here, a floating platform (a semi-sub) 10, the surface of the sea 12 and the bottom of the sea 14, are shown. The platform comprises of a drilling rig 16. A well 18 is drilled into the bed formation 20 and it runs downwards in an arc shape. The well hole comprises of a liner 22 (a casing). A plug 24 is placed a distance down into the well. The plug 24 functions such that it completely closes the passage through the liner/well hole. Thus, it is possible to carry out a test of the well. Such a test can mean that the space above the plug is pressurised. If the space can keep the

pressure, it is considered that the liner is impervious, i.e. no leaks will occur from any of the areas of the liner pipe and out into the surrounding formation. The plug 24 can be directed down by being fitted to the end of an operating string which is then directed down and is positioned by the string comprising a mechanism which can activate the securing mechanism of the plug against the wall, and set the seals against the wall of the liner so that a tight seal is formed.

An example of such a plug is shown in figure 2. The plug 30 is an assembled construction of the plug body of the crushable material 32 itself, and upper 34, middle 36 and lower slips constructions which are used to set the plug against the pipe wall/liner 40, and to maintain the necessary seal with the wall/liner. The slips are wedge-formed elements which are forced against the wall.

Indicated schematically at 42, is an explosive charge 42 which is incorporated into the crushable material. This can be activated by remote control, and will then be blown up so that the material (especially glass) is pulverised, and opens the fluid channel. The plug can have a cylindrical shape or have any shape adapted to the channel in which it shall function. Furthermore, it can be divided into sections. Instead of its own explosive charge, one can also carry out the crushing by means of pressure or other methods as described above.

Such a plug can also be fitted into an independent production pipe, or inside a liner, to test if this is leak-proof.

Figure 3 shows an alternative embodiment of a test plug 40 fully fitted in a liner-section 41. This comprises gaskets 44 and means for connection to the pressure activator 46. The test plug 40 is a pre-fabricated unit which is activated and destroyed with the aid of pressurising. The plug is fitted into a so-called pop joint, shown by 42. It is simple to fit, in that it is inserted in the string at a desired depth, and the operation is as normal with re-fill for each tenth joint.

When the liner pipes (liners) including the liner-section with the test plug, is placed in the well, it can be tested as under normal operation.

1. In order to activate and destroy the plug, this occurs by increasing the pressure by +20/30 bar above the test pressure, at which pressure the plug is destroyed. The pressure can be gradually increased upwards to the explosion pressure.

2. A time delay is achieved by the pressure being increased up to about 50 bar below the test pressure and being maintained at this level for a pre-determined time (including the testing period), for example, for 30 minutes. Thereafter, the plug is destroyed, for example, by increasing the pressure again.

With this solution according to the invention, one achieves that it is unnecessary to use any "fishing" operations to bring up the plug. One saves one run. With respect to earlier practices, one can programme the operation, or regulate the inherent properties of the plug, for a given time delay. And furthermore, it is simple to adapt to different conditions.

The mentioned time delay can also arise in that above the plug, from where the pressure is exerted, is a throttle valve, which ensures that the effect of the pressure (the increase) for direct contact with the plug must occur over a given time, before the explosion pressure is reached.

Figure 4 shows a test plug 50, with gaskets/slips 54 which can be placed in the well after the liner (liner) 56 is fitted. The test plug 50 can be driven down either on a pipe or a coil tubing, and be placed at a desired depth by pressurising. The destruction is initiated by means of pressure over time, or immediately.

The plug is fitted on a running tool and placed in the well at the desired depth. The plug 54 is set by increasing the pressure inside the tube, something which will activate

the gaskets and slips 54. The string and the tool are pulled up and the testing can start. After the test the plug can be destroyed in two ways depending on which release/destruction method has been chosen in advance.

1. Immediate destruction, to activate and destroy the plug, occurs by increasing the pressure by +20/30 bar above the test pressure, at which pressure the plug is destroyed.

2. A time delay is achieved by the pressure being increased up to about 50 bar below the test pressure and maintained at this level for a given time (including the test time), for example for 30 minutes. The plug is thereafter destroyed, for example, by the pressure being increased again.

Figure 5 shows a plug 60 which is arranged for disintegration by direct mechanical means. The plug 60 comprises a float so that it can be used for casing functions. It can be delivered as a separate plug including a tool to lower it down. The plug is destroyed by placing a drill bit in the well (where the drill bit shall be used for the drilling itself) and then gently striking the top of the plug with the drill bit so that it is destroyed.

1. The plug is easy to use and it is delivered fully pressure tested fitted onto a pop joint. The pop joint is placed in the string at a desired depth and the operation is normal with refill for each tenth joint. When the casing is placed and cemented, the plug is destroyed by simply driving down the drill bit and striking the plug so that it is crushed.

2. The plug is fitted onto the moving tool and fed down into the well to a desired depth. The plug is placed by increasing the pressure inside the pipe, and the gaskets and slips 64 are activated so that the plug is fixed. Then the string and the tool can be removed.

The cementing and testing can then start. When these operations are completed, the plug can be destroyed in the same way as above.

There are many ways in which the plug can be directed down and fitted/placed. Furthermore, there are many areas within such activities that have a need for such sealing plugs. The present invention can be used within all of these.

The abovementioned description, with reference to the figures, relates to a preferred embodiment of the invention only, and is not to be considered as limiting for the present invention. Thus, the invention can be altered and modified from the framework disclosed in the subsequent claims.

PATENT CLAIMS

1. Method for testing of a well, such as in a well liner, a newly drilled hole, and the like, characterised in
that a plug is directed into the hole,
that the plug is fixed against the wall of the well,
that the sealing means of the plug are activated to form a seal with the wall of the well, and
after the test is completed, the sealing function is removed by disintegrating the plug.

2. Method according to claim 1, characterised in that a plug made from a material which can disintegrate is used.

3. Method according to claims 1-2, characterised in that a chemical material is used, such as a cold or warm moulded material, such as compression moulded, sintered or melt cast material.

4. Method according to claims 1-3, characterised in that the plug is comprised of glass which disintegrates when exposed to pressure, such as impact pressure from a fluid, at detonation of a smaller explosive charge/ignition system with time delay, or by means of a drill bit.

5. Method according to claims 1-4, characterised in that the plug is disintegrated when exposed to pressure such as impact pressure from a fluid, or at detonation of an explosive charge/ignition system.

6. Method according to claims 1-5, characterised in that a plug which is pre-programmed to be disintegrated with a given time delay, is applied.

7. Method according to one of the preceding claims, characterised in that the test is carried out at a pressure which is lower than the disintegration pressure, whereupon the pressure is increased so that the plug is destroyed.

8. Method according to claims 1-3, characterised in that a test plug (40), which is fitted in advance to a section (41) (a liner section) which shall be placed in the well, is used.

9. Device for testing of a well, such as in a well liner, a newly drilled hole, and the like, characterised in that a plug which is arranged to be fixed against a well- or liner wall is used, that the plug comprises sealing means which are arranged to seal with the wall of the well, with the plug being comprised of a material which can disintegrate.

10. Device according to claim 9, characterised in that the plug is comprised of a ceramic material, such as a cold- or hot moulded material, such as compression moulded, sintered or melt cast material.

11. Device according to one of the claims 9-10, characterised in that the plug is comprised of glass which can be crushed and is arranged to be disintegrated when exposed to pressure such as impact pressure from a fluid, at detonation of an explosive charge/ignition system, preferably with a time delay, or by means of an external crushing appliance such as a drill bit.

12. Device according to one of the claims 9-11, characterised in that the plug is comprised of an integrated part comprising means for being fixed to a string, and the means, such as mutually displaceable slips for securing the plug against the inner wall of the liner or well wall, implements such as gasket elements arranged to be placed against a liner wall or well wall, and implements for the disintegration, such as an explosive charge with an ignition system with delayed action.

13. Device according to claims 9-12, characterised in that the plug is arranged to be disintegrated by exposure to pressure, such as impact pressure from a fluid, or is comprised of an explosive charge/ignition system which can be detonated.

14. Device according to claims 9-13, characterised in that a plug which is pre-programmed to disintegrate with a given timed delay, is used.

15. Device according to claims 1-3, characterised in that the test plug (40) is an integral part of a section (41) (a liner section) for placing in a well.

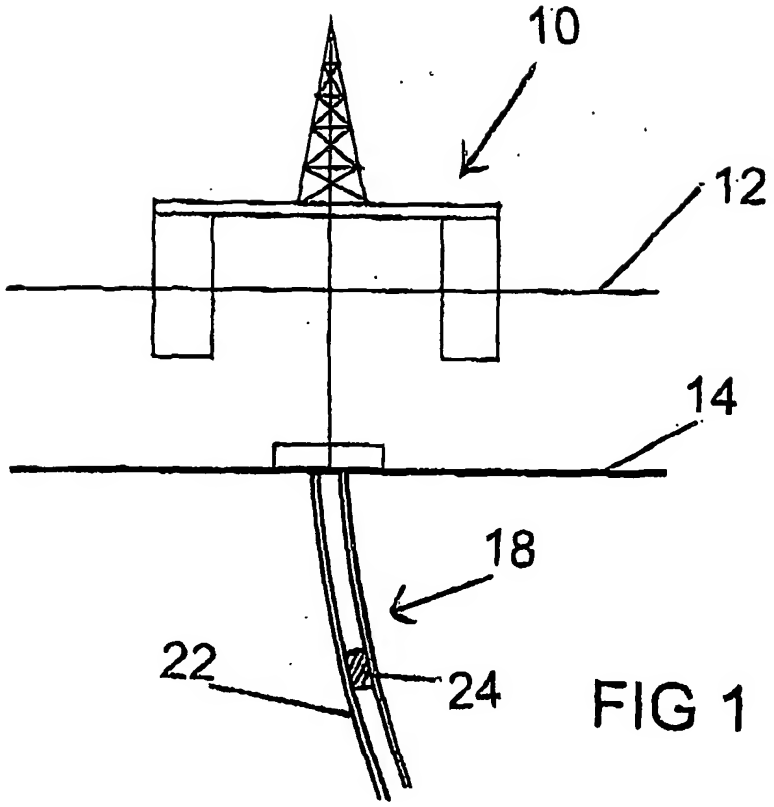

FIG 1

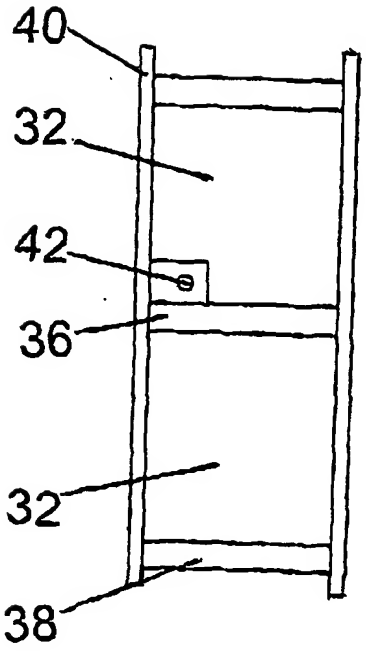

FIG 2

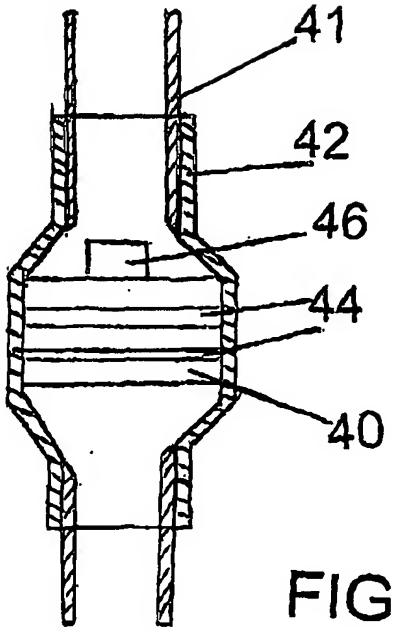

FIG 3

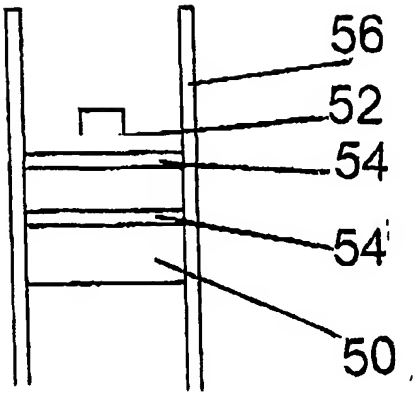

FIG 4

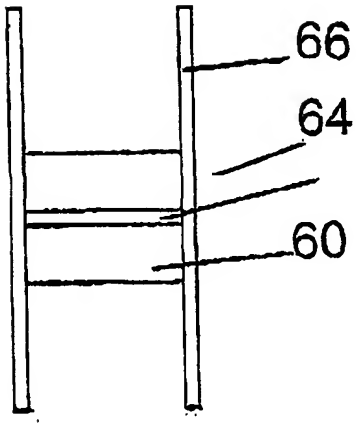

FIG 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 01/00151

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: E21B 33/13, E21B 29/00, E21B 49/00
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: E21B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-INTERNAL

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5607017 A (OWENS ET AL), 4 March 1997 (04.03.97), column 1; column 2	1-15
Y	US 4553599 A (GLOTIN), 19 November 1985 (19.11.85), The whole document	1-15
Y	US 5623993 A (VAN BUSKIRK ET AL), 29 April 1997 (29.04.97), The whole document	1-15
A	US 4862961 A (NEFF), 5 Sept 1989 (05.09.89)	1-15

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
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Date of the actual completion of the international search	Date of mailing of the international search report
6 July 2001	10 -07- 2001
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Christer Bäcknert/EK Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NO 01/00151

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4415206 A (HODGES), 15 November 1983 (15.11.83) -- --------	1-15

INTERNATIONAL SEARCH REPORT

Information on patent family members

28/05/01

International application No.
PCT/NO 01/00151

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